



May 12, 2005

TO: G. Wagemann / M. Pea
Eastern Region Design Office

FROM: T.M. Allen / J.R. Struthers
OSC Materials Laboratory MS: 47365
Geotechnical Services Division
Fax (360)709-5585

SUBJECT: SR-270, OL - 3502
Pullman to Idaho State Line Realignment Project
Supplemental Geotechnical Recommendations for Foundations

At the request of the Eastern Region Design Team, we have conducted a geotechnical evaluation of foundation conditions for a 3-sided box culvert for the Pullman to Idaho State Line Realignment Project. This memorandum presents a summary of our evaluation and final geotechnical recommendations for design and construction of the proposed box culvert. These recommendations should be considered supplemental to recommendations for grading and material use presented in the report entitled *Geotechnical Report, Pullman to Idaho State Line*, dated April 10, 2005.

PROJECT BACKGROUND

This project involves widening of the existing SR-270 to the immediate north between Pullman and Moscow, ID. The location of the project is shown in Figure 1. The widening project consists of adding additional roadway section to the immediate north and localized realignment to the north of the existing highway. Associated with this project is creation of a bridge over-crossing of the Bill Chipman Trail, which runs approximately parallel to the SR 270 alignment.

This memorandum specifically addresses the over-crossing of the Bill Chipman Trail in the vicinity of Station 11+25 on the Sunshine Road Alignment (SUN). At this location, a 3-sided box culvert will be used to cross over a portion of the trail. A plan view showing the location of the proposed structure is shown in Figure 2. Figures 3 and 4 present profile and design details for the proposed overcrossing. Footing to footing width of the structure is 14 feet; centerline length is 40 feet. Approximately 12 feet of fill will be used in the approaches to this over-crossing and proposed embankment side slopes are 3H : 1V. The box culvert is anticipated to have about 2 to 3 feet of cover, including the pavement section. The foundation and structural details for the box will be developed as

shop drawings by the contractor. Submittals will be reviewed at both the Region and Headquarters level.

FIELD INVESTIGATION

Soil conditions at the location of the proposed over crossing were investigated by Whitman County Engineering crews using excavator-dug test trenches. Test trench logs are presented in Appendix A.

SITE CONDITIONS

Regional Geology

The project is located in the Pullman-Moscow Basin, an area bounded by mountains to the north, south, and east. In this basin, basalt bedrock is overlain by wind-blown clayey silt deposits (loess) that vary considerably in thickness. Basalt bedrock consists of relatively flat lying flows of the Miocene Columbia River Basalt Group, specifically the Wanupum Basalt. This geologic unit is regionally widespread and demonstrates considerable variation in fracture characteristics, weathering, and degree of alteration, depending on its cooling history and other local conditions during flow deposition. Although not observed within the project limits, sedimentary interbeds are often present between individual basalt flows (Gulick, 1994).

Loess deposits that overlie the basalt bedrock are Pleistocene to Holocene in age and are part of an extensive dune complex that is present throughout southeast Washington. In the vicinity of Pullman and Moscow, this loess is typically clayey silt. This deposit is locally in excess of 200 feet in thickness (Schuster and others, 1997).

Site Soil Conditions

Field exploration indicates that the location of the proposed box culvert is underlain by clayey loess soils that have been reworked by local stream activity. Test trenches T-1 and T-2 encountered soft silt and clayey silt soils to depths of 15 and 12 feet, respectively.

Test Trench T-1 encountered groundwater at a depth of approximately 5 feet below ground surface. During excavation of this test trench, little side-wall sloughing was experienced and excavation activities were generally sufficient to remove water entering the trench. Test Trench T-1 encountered seepage at a depth of approximately 5 feet below ground surface.

Analysis performed for our evaluation assumes that the maximum depth of compressible soils is approximately 15 feet below ground surface and that groundwater will be encountered at about 5 feet below ground surface throughout the footing and embankment area.

GEOTECHNICAL DESIGN RECOMMENDATIONS

Seismic Considerations

For seismic design, peak horizontal acceleration coefficient of 0.06g is recommended based on the June 2002 US Geological Survey National Seismic Hazard Map. This recommended acceleration coefficient is based on an expected ground motion at the site that has an a 10 percent probability of exceedence in a 50-year period (475-year return period). Due to the relatively low anticipated ground motion, soil liquefaction is not anticipated.

Anticipated Embankment Settlement

Embankments for the project will be approximately 12 feet or less in height. We anticipate that these embankments will be constructed in accordance with Section 2-03.3(14) of the WSDOT Standard Specifications. Based on the available data and our analysis, settlement on the order of 4 inches is anticipated. Options for reducing the magnitude of this anticipated settlement are presented in the following sections.

Foundation Support

The Region Design Team has indicated a preference to use spread footings to support this structure. Analysis suggests that excessive foundation settlement will occur due to loading imposed by the approach embankment if foundation subsoil conditions are not improved prior to construction. Two options that may be used to mitigate potential settlements are: 1) excavation and replacement of compressible soils with granular fill and 2) pre-loading the area with the proposed 12-foot tall embankment prior to construction.

Excavation and Removal

For the excavation and replacement option, soils within the foundation and approach embankment area should be removed to approximately elevation 2480 feet. The area of removal should begin 1 foot outboard from the edge of the proposed footing and extend down to bedrock at a slope of 1H : 1V, as shown in Figure 5. Construction of stable temporary excavation side slopes or the use of shoring will be at the Contractors discretion. For estimating purposes, 1H : 1V temporary side slopes can be assumed to assess excavation limits. The area excavated should be backfilled with gravel borrow or better material. This backfill should be compacted to Method C requirements as described in Section 2.03.3(14)C of the *WSDOT Standard Specifications*.

Note that groundwater will likely be encountered during excavation. Dewatering will likely be required during excavation and replacement activities. If groundwater is present in the excavation at the time of backfill, quarry spalls should be used to bring the elevation of the fill to above the groundwater surface. Where quarry spalls are placed as backfill, no compaction of the quarry spalls is required. Where quarry spalls are used as

backfill, a minimum thickness of 1.5 feet of compacted gravel borrow will need to be placed above them to fill excessive voids in the quarry spalls and act a leveling course for either foundation construction or the placement of additional backfill.

Site Pre-Loading

As an alternative to complete excavation and replacement, we recommend pre-loading the site with the proposed 12-foot tall embankments in advance of construction for the structure. Prior to placement of this embankment fill, we recommend the footprint area of the structure and approach abutments be excavated to a depth of 5 feet below adjacent grade. Embankments will be constructed in accordance with Section 2-03.3(14) of the WSDOT Standard Specifications.

Following construction, the embankment should remain in place for approximately 3 months prior to continuing with construction activities. Following this period, the central portion of the embankment may be excavated to the foundation bearing elevation to accommodate the structure. If post-construction settlement of the embankment is monitored using settlement plates, it may be possible to justify a reduction in this waiting period.

Spread Footing Design Parameters

Proposed spread footings for this structure will bear on granular backfill. We recommend the following parameters be utilized in development of the spread footing design. Total settlement based on these parameters and the two recommended options (presented above) is anticipated to be less than 1 inch.

Table 1 – Recommended Spread Footing Design Parameters

Parameter	Value
Bearing Elevation	2487 feet MSL
Minimum Depth (top of footing)	2 feet
Overexcavation and Replacement	
Allowable Bearing Capacity	10,000 psf
Bearing Soil Friction Angle (ϕ_f)	35°
Site Preloading	
Allowable Bearing Capacity	2,500 psf
Bearing Soil Friction Angle (ϕ_f)	28°

The parameters provided in the following section, *Lateral Load Analysis*, are appropriate for resistance of lateral loads on foundation elements. We recommend, however, that passive resistance in front of spread footings be ignored for the full depth of the footing.

Lateral Load Analysis

Abutment walls should be designed using the lateral earth pressure coefficients and soil parameters presented in the following table.

Table 2 - Lateral Earth Pressure Coefficients and Soil Parameters

Parameter	Value
Backfill Unit Weight (γ)	130 pcf
Backfill Soil Friction angle (ϕ_f)	35°
At-Rest Earth Pressure (K_o)	0.43
Bearing Soil Friction Angle (ϕ_f)	35°
Passive Earth Pressure (K_p) - Unfactored	4.4
Coefficient of Sliding	0.6
Seismic Coefficient (K_{ae})	0.43

We recommend disregarding the upper 2 feet of soil against the front face of the abutment wall when determining passive soil resistance.

The lateral earth pressure due to traffic surcharge loading should be considered as a uniformly distributed load at the ground surface of 250 psf multiplied by the at-rest earth pressure coefficient, K_o .

CONSTRUCTION RECOMMENDATIONS

If deleterious materials are encountered during preparation of foundation and approach embankment areas, we recommend that the unsuitable material be over-excavated and replaced with gravel borrow or better material. This backfill should be compacted to Method C requirements as described in Section 2.03.3(14)C of the *WSDOT Standard Specifications*. We recommend that this office be contacted during footing excavation and subgrade preparation to verify subsurface conditions.

Groundwater will likely be encountered during construction of the excavation and replacement option, presented above. Excavation below the water table will require dewatering. To minimize construction dewatering, excavation should occur in the drier summer months. Design, construction and maintenance of the dewatering system should be the responsibility of the Contractor.

G. Wagemann/M. Pea
May 12, 2005

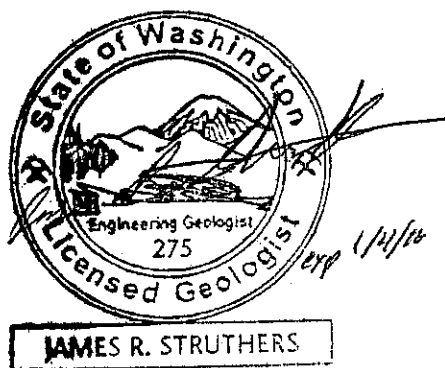
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If you have any questions then please contact James Struthers at (360) 709-5409 or Jim Cuthbertson at (360) 709-5452.

TMA:jrs

Attachments: Figures 1 through 5
Appendix A

cc: G.E. Gibson, Eastern Region Materials Engineer, ERO
K.A. Metcalf, Eastern Region Project Development, ERO
R.W. Robertson, Eastern Region Construction, ERO



Prepared by: James R. Struthers, L.E.G.
Project Engineering Geologist



Reviewed by: James Cuthbertson, P.E.
Chief Foundation Engineer


Approving Authority: Tony M. Allen, P.E.
State Geotechnical Engineer

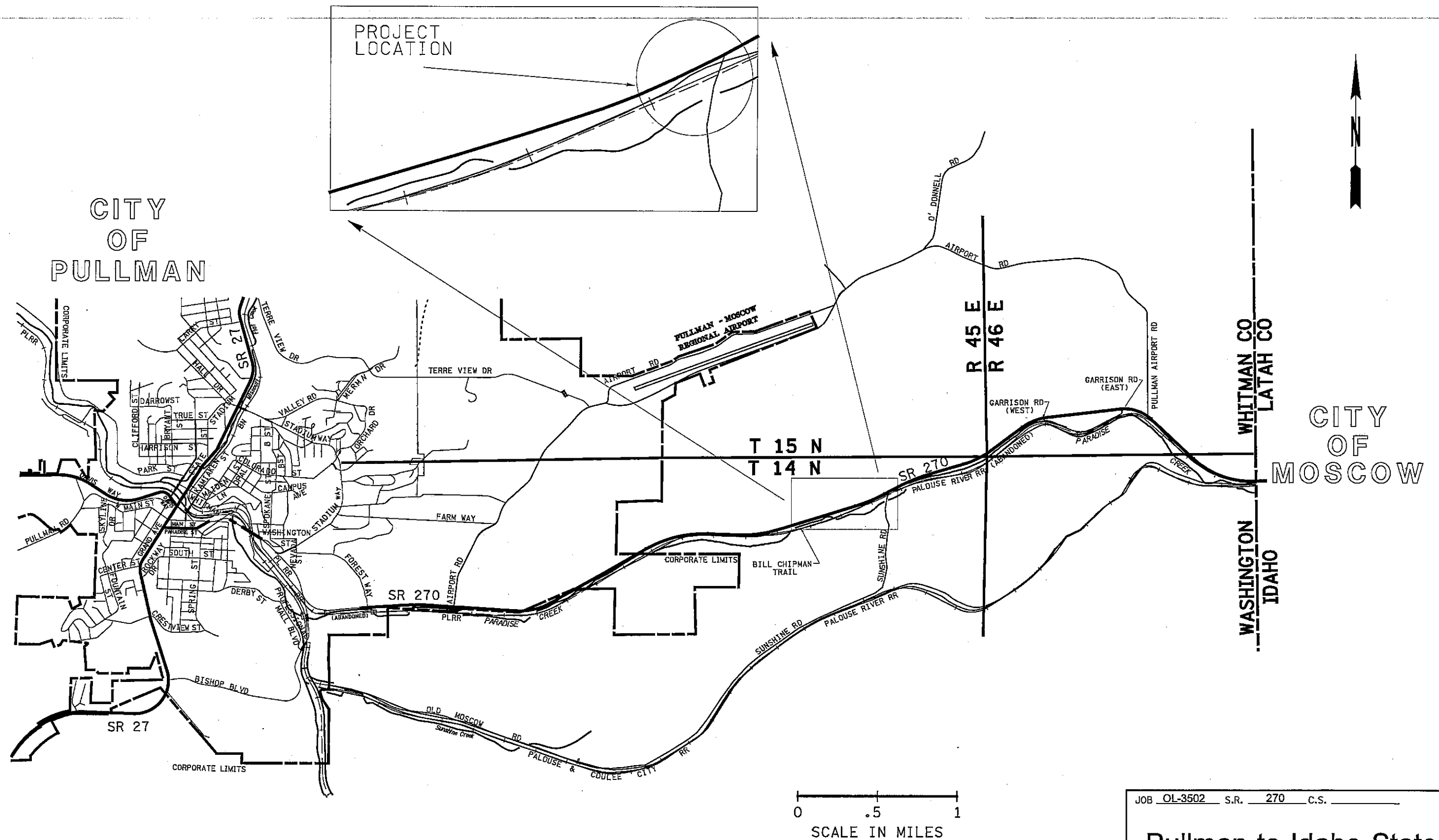
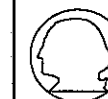


Figure 1: Vicinity Map

JOB OL-3502 S.R. 270 C.S. _____

Pullman to Idaho State Line



WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 5/2005
SCALE N.T.S. VERT. _____
HORIZ. _____
SHEET ____ OF ____
DRAWN BY W.M.

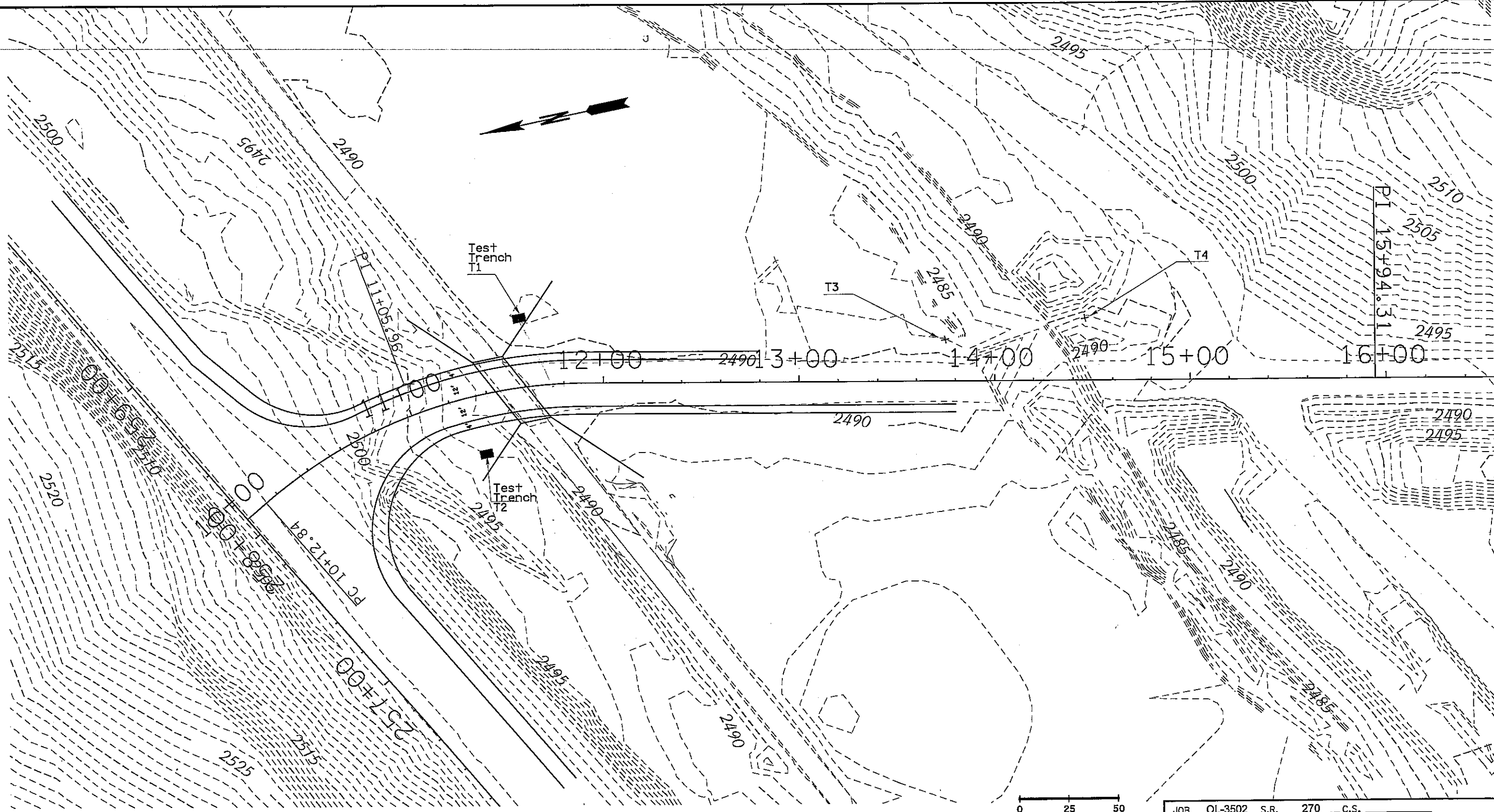

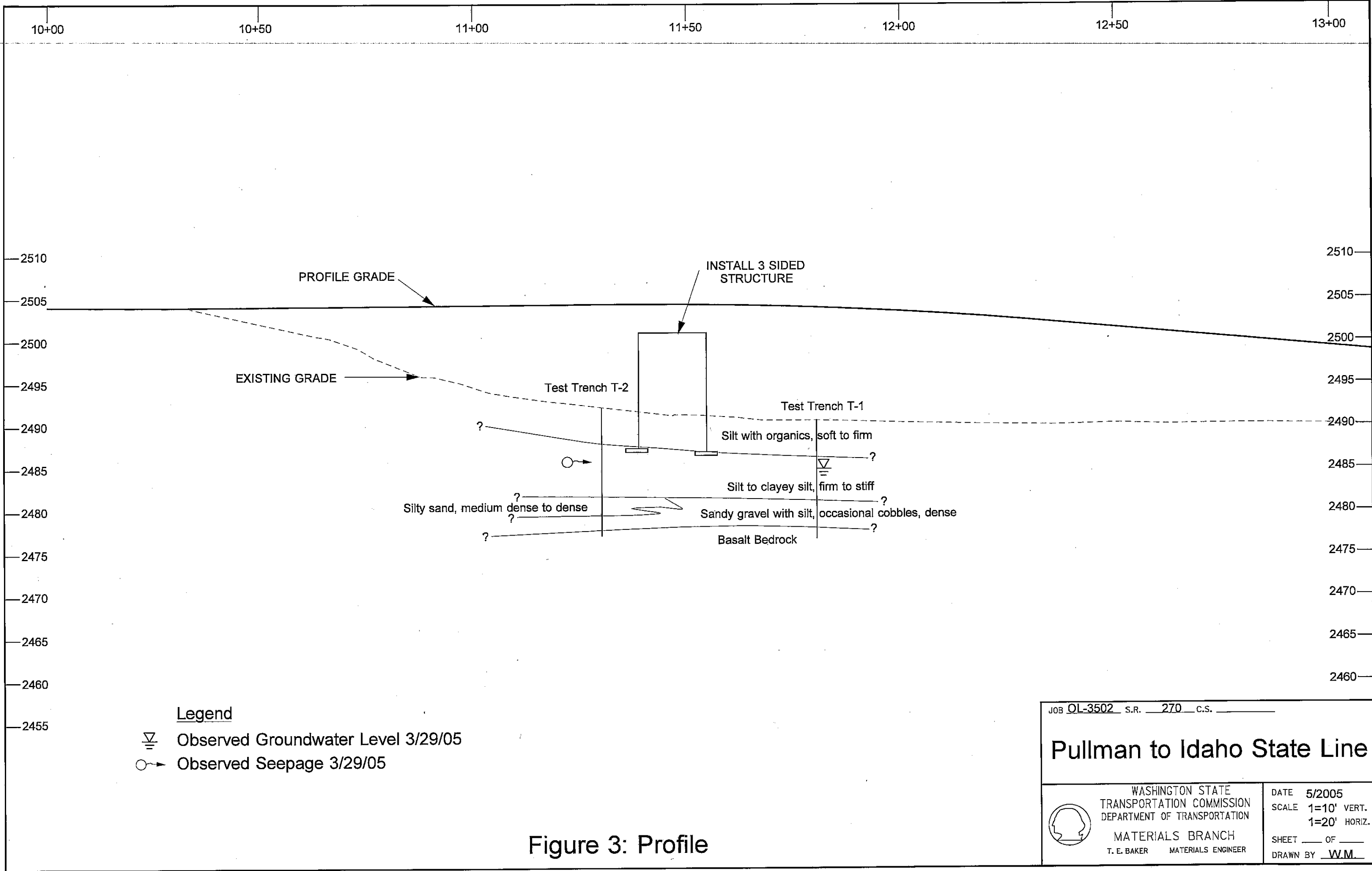


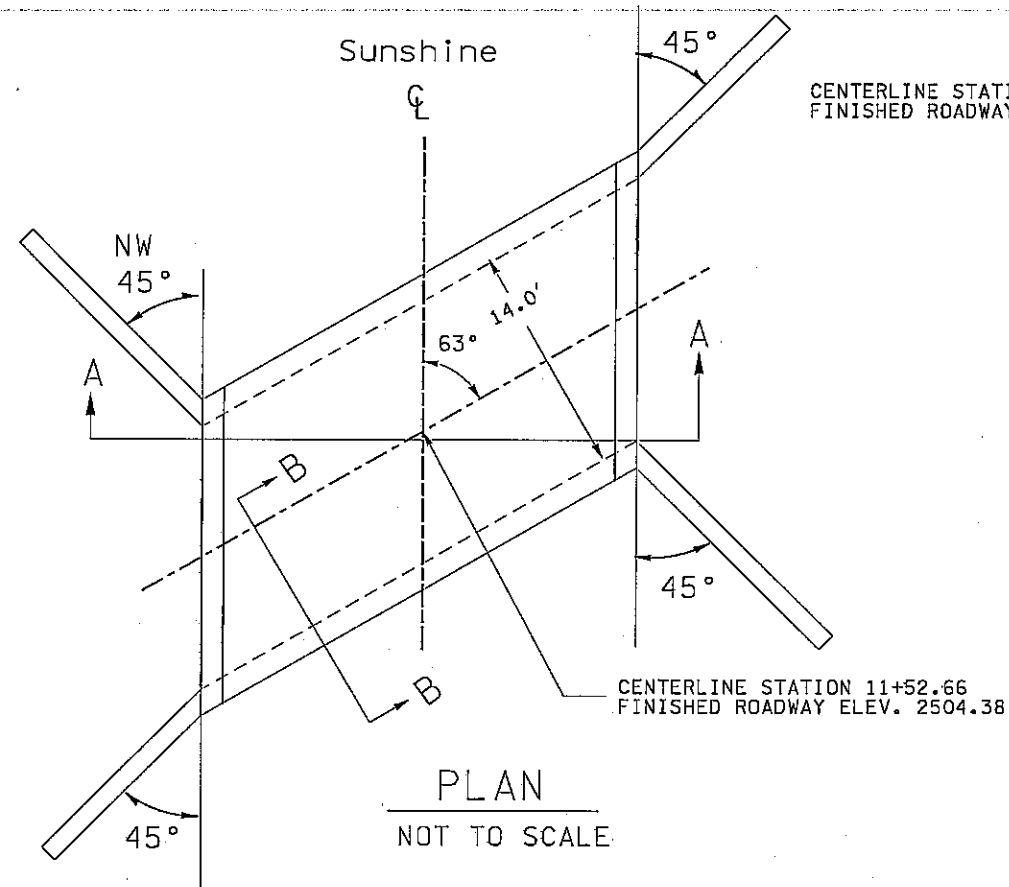
Figure 2: Plan

JOB OL-3502 S.R. 270 C.S.	
<h3>Pullman to Idaho State Line</h3>	
 <p>WASHINGTON STATE TRANSPORTATION COMMISSION DEPARTMENT OF TRANSPORTATION</p>	DATE 5/2005
	SCALE 1"=200'
	VERT. _____
	HORIZ. _____
<p>MATERIALS BRANCH</p> <p>T. E. BAKER MATERIALS ENGINEER</p>	
<p>SHEET _____ OF _____</p> <p>DRAWN BY W.M.</p>	



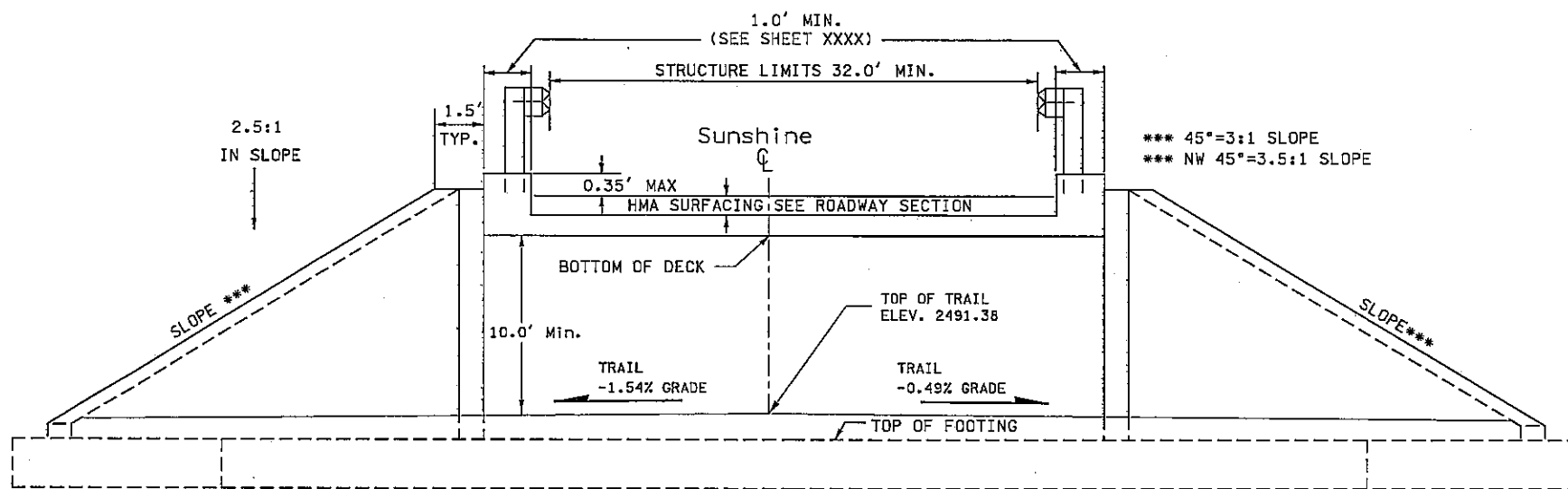
3-SIDED STRUCTURE MP 7.33 TRAIL

COUNTERCLOCKWISE
STRUCTURE SKEW
ANGLE = 27°

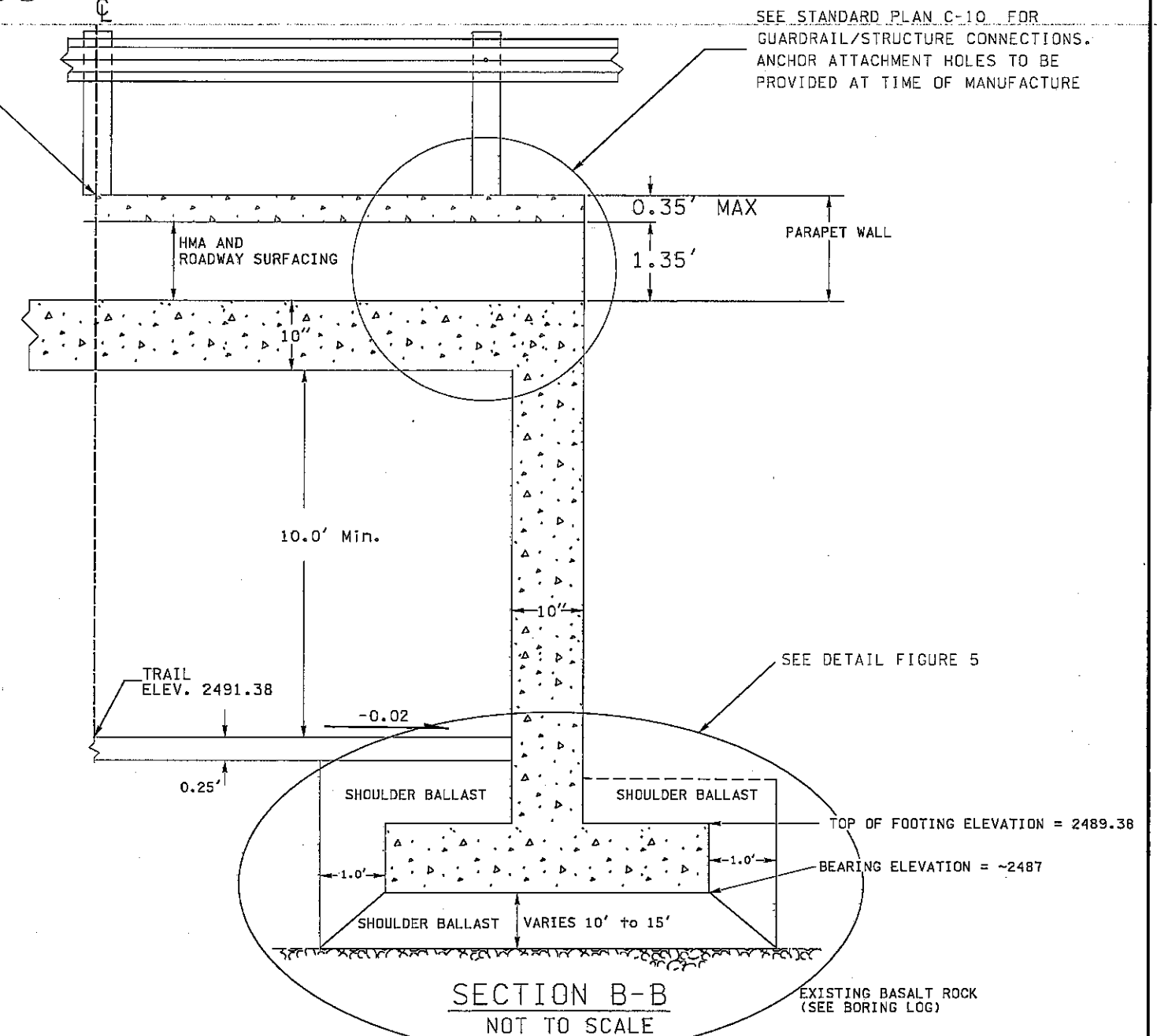


CENTERLINE STATION 11+52.66
FINISHED ROADWAY ELEV. 2504.38

CENTERLINE STATION 11+52.66
FINISHED ROADWAY ELEV. 2504.38



*** 45°=3:1 SLOPE
*** NW 45°=3.5:1 SLOPE



SEE STANDARD PLAN C-10 FOR
GUARDRAIL/STRUCTURE CONNECTIONS.
ANCHOR ATTACHMENT HOLES TO BE
PROVIDED AT TIME OF MANUFACTURE

SEE DETAIL FIGURE 5

TOP OF FOOTING ELEVATION = 2489.38
BEARING ELEVATION = ~2487

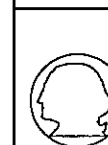
EXISTING BASALT ROCK
(SEE BORING LOG)

NOTES:

1. BOTTOM OF DECK TO TRAIL SHALL MEASURE NO LESS THAN 10.0 FT.
2. ALL COMPACTION SHALL BE METHOD "C".
3. SEISMIC DESIGN OF THE STRUCTURE SHALL HAVE AN ACCELERATION COEFFICIENT OF 0.06 g IN ACCORDANCE WITH THE JUNE 1996 US GEOLOGICAL SURVEY NATIONAL SEISMIC HAZARD MAP.

JOB OL-3502 S.R. 270 C.S. _____

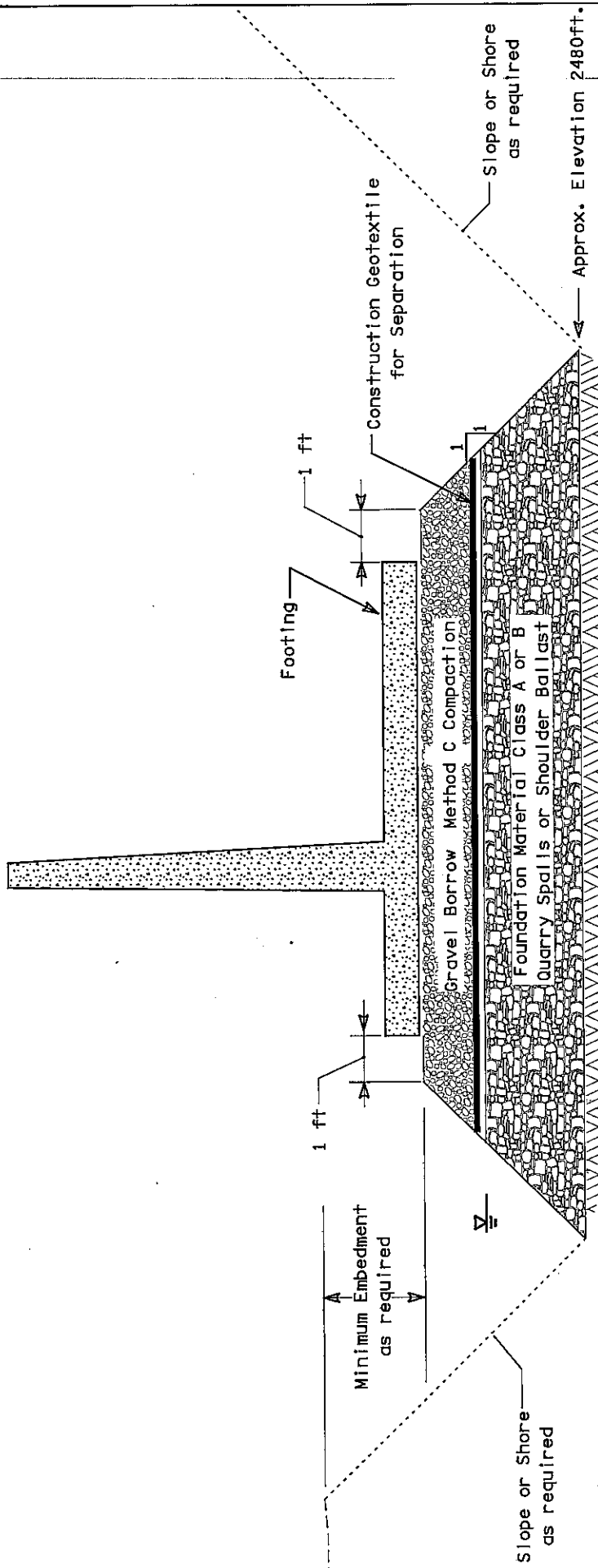
Pullman to Idaho State Line



WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 5/2005
SCALE N.T.S. VERT.
HORIZ.
SHEET ____ OF ____
DRAWN BY W.M.

Figure 4: 3-Sided Structure



NOTE: Foundation Material Class A or B, quarry spalls, or shoulder Ballast shall be placed to above the surface of water, if water is present within 1ft of the footing.
 Above the water, or if no water is present, Gravel Borrow with method C compaction shall be used.

JOB 01-3502 S.R. 270 C.S. LAYOUT

Pullman to Idaho State Line

WASHINGTON STATE
 TRANSPORTATION COMMISSION
 DEPARTMENT OF TRANSPORTATION

DATE 4/2004
 SCALE N.T.S.
 SHEET 1 OF 1
 DRAWN BY T.E. BAKER
 MATERIALS ENGINEER

Figure 5: Overexcavation Detail



Job No. OL-3502 SR 270 Elevation 2491.0 (759.3 m)

HOLE No. T1

Sheet 1 of 1

Project Pullman to Moscow (Structures)

Driller _____ Lic# _____

Site Address _____

Inspector _____

Start April 1, 2005 Completion April 1, 2005 Well ID# _____ Equipment Komatsu 120

Station _____ Offset _____ Casing _____ Method Trench

Northing _____ Easting _____ Latitude _____ Longitude _____

County Whitman Subsection _____ Section _____ Range _____ Township _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
1											SILT (Topsoil/Alluvium) - contains some organics, dark brown, soft to firm		
5											SILT (Alluvium) - brown, porous, firm to stiff, moist to saturated. Free ground water present at approximately 4.5 feet	▽	
2											SILT, clayey (Alluvium) - some plastic fines and minor sand near the top, yellowish brown, minor roots and fine organics, porous structure, very moist to wet, stiff		
10											SILT, gravelly (Alluvium) - contains sand and large cobbles to 6 inches, brown to yellow brown, saturated, dense (behaves as granular soil)		
4											GRAVEL, sandy (Alluvium) - coarse grained, subrounded to rounded, well graded, yellowish brown, saturated, dense to very dense BASALT (Bedrock) - highly fractured to cobbles, weathered, dark gray to black, saturated, dense		
15											This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Groundwater encountered approximately 4.5 feet below ground elevation.		
5													
6													
20													



LOG OF TEST BORING

Start Card _____

Job No. OL-3502 SR 270 Elevation 2493.0 (759.9 m)

HOLE No. T2

Sheet 1 of 1

Project Pullman to Moscow (Structures)

Driller _____ Lic# _____

Site Address _____

Inspector _____

Start April 1, 2005 Completion April 1, 2005 Well ID# _____ Equipment Komatsu 120

Station _____ Offset _____ Casing _____ Method Trench

Northing _____ Easting _____ Latitude _____ Longitude _____

County Whitman Subsection _____ Section _____ Range _____ Township _____

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft				SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			10	20	30	40							
1											SILT (Topsoil/Alluvium) - contains some organics, dark brown, soft to firm		
5											SILT (Alluvium) - brown, porous, firm, moist to saturated. Free ground water present at approximately 5 feet		
2											SILT, clayey (Alluvium) - some plastic fines, yellowish brown to tan with depth, minor roots and fine organics, porous structure, very moist to wet, stiff		
10											SAND, silty (Alluvium) - medium grained, subrounded, poorly graded, brown to yellow brown, saturated, medium dense to dense		
4											GRAVEL & COBBLES (Basalt Alluvium) - coarse grained, angular to subrounded, poorly graded, dark gray to black, saturated, dense to very dense		
15											BASALT (Bedrock) - highly fractured to cobbles, weathered, dark gray to black, saturated, dense		
5											This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
											Groundwater seepage encountered approximately 5 feet below ground elevation.		
20													